CLAIMS

1. (Amended) A method of forming a solid of a ferroelectric or a high dielectric material by calcining organic compounds containing metal elements, comprising:

a step of forming a film by coating a solution of an organic compound material containing a metal element over a substrate;

an organic substance removing step of removing organic substances from said film by applying organic substance removing treatment that uses means other than heat to said organic compound material containing metal element, thereby obtaining inorganic compound material; and

a crystallizing step of calcining to crystallize said inorganic compound material obtained in said organic substance removing step, thereby obtaining a solid of a ferroelectric or a high dielectric material.

2. (Amended) The method of forming a solid of a ferroelectric or a high dielectric material according to Claim 1 or 34, wherein said organic substance removing step includes a depressurizing step of placing said organic compound material in a low-pressure atmosphere.

3. (Amended) The method of forming a solid of a ferroelectric or a high dielectric material according to Claim

2, wherein said crystallizing step is carried out after said depressurizing step.

4. (Amended) The method of forming a solid of a ferroelectric or a high dielectric material according to Claim 2, wherein said depressurizing step and crystallizing step are carried out simultaneously by calcining said organic compound material in the low-pressure atmosphere.

5. (Amended) The method of forming a solid of a ferroelectric or a high dielectric material according to any of Claims 1 through 4 and 34, wherein said organic substance removing step includes a step of giving energy other than heat to said organic compound materials.

6. (Amended) The method of forming a solid of a ferroelectric or a high dielectric material according to Claim 5, wherein said step of giving energy other than heat includes an electromagnetic wave supplying step of supplying an electromagnetic wave to said organic compound material.

7. (Amended) The method of forming a solid of a ferroelectric or a high dielectric material according to Claim 5 or 6, wherein said step of giving energy other than heat includes a step of treating said organic compound materials with

activated oxygen particles.

8. (Deleted)

9. (Amended) The method of forming a solid of a ferroelectric or a high dielectric material according to any of Claims 1 through 8, 34, and 35, wherein said inorganic compound solid is a complex oxide.

10. (Amended) A method of manufacturing a semiconductor device, comprising a step of forming, on a semiconductor substrate, a functional thin film made of a solid of a ferroelectric or a high dielectric material formed by the method according to any of Claims 1 through 9, 34, and 35.

11. The method of manufacturing a semiconductor device according to Claim 10, further comprising:

a restoring step of restoring characteristics deterioration of said functional thin film caused by influences in a step carried out after said functional thin film is formed, said restoring step including:

a treatment step of giving energy other than heat to said functional thin film; and

a heat treatment step of giving thermal energy to said functional thin film.

12. The method of manufacturing a semiconductor device according to Claim 11, wherein said restoring step further includes an oxygen introducing step of introducing an oxidation gas to a surface of said semiconductor substrate having formed thereon said functional thin film.

13. The method of manufacturing a semiconductor device according to Claim 11 or 12, wherein said treatment step of giving energy other than heat to said functional thin film includes an oxygen activated particle treatment step of placing said semiconductor substrate having formed thereon said functional thin film in an oxygen activated particle atmosphere.

14. The method of manufacturing a semiconductor device according to any of Claims 11 through 13, wherein said treatment step of giving energy other than heat to said functional thin film includes an electromagnetic wave supplying step of supplying an electromagnetic wave to said functional thin film.

15. The method of manufacturing a semiconductor device according to any of Claims 11 through 14, further comprising a wire forming step of forming a wiring on said semiconductor substrate before said restoring step.

16. The method of manufacturing a semiconductor device according to Claim 15, wherein said heat treatment step is carried out such that a temperature of said semiconductor substrate does not exceed a certain temperature predetermined so as not to deteriorate said wiring.

17. The method of manufacturing a semiconductor device according to any of Claims 11 through 16, further comprising an element forming step of forming a functional element on said semiconductor substrate before said restoring step.

18. The method of manufacturing a semiconductor device according to Claim 17, wherein said heat treatment step is carried out such that a temperature of said semiconductor substrate does not exceed a certain temperature predetermined so as not to deteriorate said functional element.

19. The method of manufacturing a semiconductor device according to any of Claims 10 through 18, comprising an element forming step of forming a functional element on said semiconductor substrate before said step of forming said functional thin film.

20. The method of manufacturing a semiconductor device according to Claim 19, wherein said crystallizing step is

carried out at or below a certain temperature predetermined so as not to deteriorate characteristics of said functional element.

21. The method of manufacturing a semiconductor device according to any of Claims 10 through 20, wherein said crystallizing step is carried out at a predetermined temperature lower than a temperature, at or above which mutual-diffusion of materials occurs between said functional thin film and a solid adjacent thereto.

22. The method of manufacturing a semiconductor device according to any of Claims 10 through 21, wherein:

said functional thin film is a ferroelectric thin film; and

said semiconductor device is a ferroelectric storage device employing said ferroelectric thin film as a charge holding film.

23. A method of manufacturing a semiconductor device, comprising:

a step of forming a functional thin film on a semiconductor substrate; and

a restoring step of restoring characteristics deterioration of said functional thin film caused by influences

during a step carried out after said functional thin film is formed,

said restoring step including:

a treatment step of giving energy other than heat to said functional thin film; and

an heat treatment step of giving thermal energy to said functional thin film.

24. The method of manufacturing a semiconductor device according to Claim 23, wherein said functional thin film is a complex oxide thin film.

25. The method of manufacturing a semiconductor device according to Claim 23 or 24, wherein said restoring step further includes an oxygen introducing step of introducing an oxidation gas to a surface of said semiconductor substrate having formed thereon said functional thin film.

26. The method of manufacturing a semiconductor device according to Claims 23 through 25, wherein said treatment step of giving energy other than heat to said functional thin film includes an oxygen activated particle treatment step of placing said semiconductor substrate having formed thereon said functional thin film in an oxygen activated particle atmosphere.

27. The method of manufacturing a semiconductor device according to any of Claims 23 through 26, wherein said treatment step of giving energy other than heat to said functional thin film includes an electromagnetic wave supplying step of supplying an electromagnetic wave to said functional thin film.

28. The method of manufacturing a semiconductor device according to any of Claims 23 through 27, further comprising a wiring forming step of forming a wiring on said semiconductor substrate before said restoring step.

29. The method of manufacturing a semiconductor device according to Claim 28, wherein said heat treatment step is carried out such that a temperature of said semiconductor substrate does not exceed a certain temperature predetermined so as not to deteriorate said wiring.

30. The method of manufacturing a semiconductor device according to any of Claims 23 through 29, further comprising an element forming step of forming a functional element on said semiconductor substrate before said restoring step.

31. The method of manufacturing a semiconductor device according to Claim 30, wherein said heat treatment step is carried out such that a temperature of said semiconductor

substrate does not exceed a certain temperature predetermined so as not to deteriorate said functional element.

32. The method of manufacturing a semiconductor device according to any of Claims 23 through 31, wherein said functional thin film is a ferroelectric thin film.

33. The method of manufacturing a semiconductor device according to Claim 32, wherein said semiconductor device is a ferroelectric storage device employing said ferroelectric thin film as a charge holding film.

34. (New) The method of forming a solid of a ferroelectric or a high dielectric material according to Claim 1, wherein said step of forming said film includes a step of performing precalcining after said solution coated on said substrate is dried.

35. (New) The method of forming a solid of a ferroelectric or a high dielectric material according to Claim 7, wherein said activated oxygen particles include oxygen radical.